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ENABLEMENT OF QUICK REMOTE ACCESS TO CT SCANS TO IMPROVE WORKFLOW AND PATIENT THROUGHPUT**DESCRIPTION**

The present invention relates to the diagnostic imaging systems and methods. It finds particular application in conjunction with improving the throughput of CT scanners and other diagnostic equipment and will be described with particular reference thereto. However, it is to be appreciated that the invention will also find 5 application in conjunction with improving medical processing efficiency, diagnostic efficiency, and the like.

Typically, in a CT scan, the patient is loaded into a patient support couch and taken into the CT scan room. A set of diagnostic images is generated by a CT scan technician from the exam room which is usually adjacent to the scan room. If there is any 10 question whether the scan had the right contrast, covered the right region, or the like, it is necessary to page the medical specialist who can be in some other remote part of the hospital performing other duties. Depending on the size of the hospital, there could be a 15 10-15 minute wait for the paged medical specialist to terminate the duties being performed and reach a viewing terminal, review the images, and approve them. Interrupting a consultation with another patient or physician may not be appropriate. The patient is held 15 in the scan room until the approval is made and the reviewing medical specialist authorizes patient's release.

Furthermore, in many CT scan protocols, the patient is injected with a contrast agent prior to imaging. During the delay, the contrast agent is being removed 20 from the region of interest, e.g., by the patient's kidneys. If the delay was too long and a further set of images is required, the contrast agent concentration will have dropped below acceptable levels for the protocol. Re-injection of the contrast agent is a highly undesirable medical procedure. First, the contrast agent is often mildly toxic and overexposure can have negative physiological consequences. Second, gauging the amount 25 of contrast agent to add by re-injection without overdosing the patient is difficult. The delay and re-injection creates concerns particularly with the pediatric patients who tend to be more sensitive to the contrast agents.

In addition, the healthcare system, and the diagnostic medical imaging as an integral part of it, is facing a challenging situation of shrinking budgets, increasing cost pressure, and growing demands to increase both the efficiency and quality of services. Professionalism and success are based on a strict approach to customer orientation and cost effectiveness.

Accordingly, there is a need to improve the workflow between the scan room personnel and the reviewing medical personnel to provide a speedy review of the scans for accuracy and completeness without burdening patients.

The present invention provides a new and improved apparatus and method 10 which overcomes the above-referenced problems and others.

In accordance with one aspect of the present invention, an imaging communication system for communicating between an imaging workstation, from which 15 imaging protocols can be conducted and at which diagnostic images can be displayed, and one or more medical professionals is disclosed. A means selects and addresses one or more medical professionals. A means selects electronic image representations to be sent to the one or more selected medical professionals. A means formats the at least one selected 20 medical professional's address and the selected electronic image representations into a wireless transmission format. A plurality of remote receiving means receives wireless transmissions at remote locations. An address reading means is connected with each of the plurality of receiving means for examining each received wireless transmission for a corresponding preselected address. A video processing means is connected with each 25 remote receiving means for, in response to the address reading means finding the corresponding preselected address in the received wireless communication, converting an electronic image portion of the received wireless transmission into an appropriate format for human-readable display.

In accordance with another aspect of the present invention, a method of 30 imaging communications between an imaging workstation and one or more medical professionals is disclosed. An address of a medical professional and diagnostic images to be sent to the medical professional are selected. The medical professional's address and the images are formatted for wireless transmission. Wireless transmissions are

received at remote locations. Each received wireless transmission is examined for a corresponding preselected address. After the corresponding preselected address is found in the received wireless communication, an electronic portion of the received wireless transmission is converted into an appropriate format for human-readable display.

5 One advantage of the present invention resides in a speedy review of scans for accuracy and completeness and timely release of patients from the scanning premises.

Another advantage resides in improved patient satisfaction.

Another advantage of the present invention resides in the optimization of communications between the imaging technician and the reviewing medical personnel.

10 Other advantages include that the scan technician and the medical personnel can communicate and react quickly in the emergency situations, costs and response times are reduced, the quality of the outcome for the patients increases, therapeutic decisions are accelerated (e.g., real-time scanning), and unnecessary waiting times for current patients and those awaiting services are avoided.

15 Still further advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

20 The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not be construed as limiting the invention.

FIGURE 1 is a diagrammatic illustration of the two-directional
25 communication system;

FIGURE 2 is a diagrammatic illustration of a part of the two-directional communication system that is positioned in the vicinity of a scanner;

FIGURE 3 is a diagrammatic illustration of a part of the two-directional communication system that is positioned in one or more remote locations; FIGURE
30 4 is a block-diagram of a work-flow between an imaging technician and a reviewing medical professional.

With reference to FIGURE 1, a two-way communications link 10 is established between a medical professional such as radiologist and imaging technician in a multi-media bi-directional communication system 12. The radiologist and imaging technician can communicate verbally, the radiologist can dictate notes, the patient chart or 5 records can be sent as well as real-time images of the patient. Of course, it is contemplated that the communications can take place between the imaging technicians and other medical professionals such as physicians, cardiologists, other imaging technicians, and the like.

Typically, a patient is taken into a scanning room 14, which contains scanning apparatus 16. The imaging technician performs a scan using a workstation 18 10 loaded with software 20 and located in a technician's room 22.

With reference to FIGURE 2, diagnostic data from the scanner 16 is reconstructed by a reconstruction processor 30 into electronic image representations which are stored in a diagnostic image memory 32. The reconstruction processor 30 may be incorporated into the workstation 18, the scanner 16, or may be a shared resource among a 15 plurality of scanners and workstations. The diagnostic image memory 32 preferably stores a three-dimensional image representation of an examined region of the subject. A video processor 34 converts selected portions of the three-dimensional image representation into appropriate format for display on a video monitor 36. An operator input device, such as a keyboard 38 controls a diagnostic image selecting means 40, which selects orthogonal slice 20 images, oblique slices images, projections, three-dimensional renderings, or other portions of the three-dimensional diagnostic image representation.

With reference again to FIGURE 1 and continuing reference to FIGURE 2, the imaging technician views reconstructed images 42 on the monitor 36 and sends them to the radiologist via transmitting/receiving means or transmitter/receiver 44 coupled to 25 workstation hardware 48. More specifically, the technician at the workstation 18 uses the keyboard 38 to access radiologist's address means 50 and the image selecting means 40 that send the selected address and the selected image representations to a formatting means or software 46, which formats the images and the selected address into appropriate format for wireless transmission by the transmitting/receiving means 44. Optionally, the 30 formatting means 46 may also incorporate electronic signals, which will cause a beep or other attention getter 52 when the formatted message is read. Optionally, a microphone 54 is disposed adjacent the workstation 18 so that the technician can also generate voice

instructions, which are also formatted into the message, either as audio signals or as text signals, after being converted by voice recognition software 56.

With continuing reference to FIGURE 1, the radiologist reviews the images 42 using a personal digital assistant device (PDA) or a tablet PC or other portable hardware 5 unit 60, which has an associated remote transmitting/receiving means or transmitter/receiver 62. The radiologist communicates back to the workstation 18 that the patient can be released or requests more information. Software 64, loaded into the portable hardware unit 60, is compatible with the software 20 loaded into technician's workstation 18.

10 With reference to FIGURE 3, the software 64 includes a receiver or demodulator 66 which makes any necessary formatting adjustments of a received wireless message. An address reader 68 reads the address of each received message. If a received message is addressed to the receiving portable unit 60, image representations in the message are passed to a video processor 70, which formats the representations into 15 appropriate form for display on a video display or monitor 72. Voice signals, a beep, or other audio signals are passed to a speaker 74. To reply to the workstation 18, the portable unit includes a microphone 76 into which the diagnostician can send verbal instructions to the operator at the workstation 18 to release the patient, conduct additional scans, reduce some of the scans with different parameters, or the like. In some situations, such as when 20 the diagnostician is consulting with a patient or other physicians, a verbal reply may be inappropriate. To this end, the video display 72 includes a touch screen 78, either incorporated into the monitor 72 itself or through an overlay, laser grid, or the like. Various touch screen displays are contemplated, such as an "accept" button 80. Optionally, the portable unit 60 may also include a keypad 82 or a joystick 84. The control 25 signals are used to select an address of the workstation or other remote unit from an address memory 86. A formatting means or software 88 formats the instruction signals and the address into appropriate format for transmission by the transmitter/receiver 62.

30 Optionally, the radiologist may chose to contact another remote unit to consult with that radiologist. One of the input means is used to select the address of that radiologist's remote unit from the address memory 86 and controls a forwarding means or software 90, which forwards all or selected ones of the received images along with the conferring radiologist's address to the formatting means or software 88. Optionally, the

microphone 76 is connected with a recorder 92 such that the radiologist can record notes for later replay or transcription.

With reference again to FIGURE 2, the further instructions to the technician at the workstation 18 are received at the transmitter/receiver 44. A receiving and decoding means 94, along with receive portions of the transmitter/receiver 44 decodes the received message into appropriate format for further analysis and utilization by the software 20. An address reader 96 determines whether the workstation 18 is the addressed recipient of a received message. If so, it forwards audio portions of the received message to a speaker 98. Text or the input to pushbuttons on the touch screen are forwarded to a text or graphics processor 100 which causes the video processor 34 to superimpose appropriate text or icon messages on the video display 36.

With reference again to FIGURE 1, the two-way communication can be established over an existing or added hospital network 110. The workstation 18 may be hardwired to the network or may communicate with it by way of a wireless interface 44-112. The hospital network includes a plurality of wireless interfaces 114 in different rooms of the hospital that can communicate with the wireless receiving/transmitting units 62 of the portable units 60. In this manner, the technician at the workstation 18 can communicate with radiologists at remote locations around the hospital. As yet another alternative, the workstation 18 or the hospital network can be connected via land lines or cell phone connections to a cell phone tower 116. The transmitter/receiver unit 62 of the portable units 60 can be configured to receive messages wirelessly over cell phone lines. This enables the images to be forwarded to radiologists who are located in a region of the hospital where there are no wireless interfaces or at locations remote from the hospital.

With continuing reference to FIGURE 1 and reference again to FIGURE 2, a camera 120 is optionally mounted in the scan room to view the patient being scanned. The exterior appearance of a patient can be of particular significance when diagnosing trauma victims. The camera is connected with an electromechanical controller 122 which can be used to change the field of view of the camera by zooming its lens, tipping the camera to different angles, and the like. The electromechanical controller 122, preferably, can adjust the focus of the camera 120. If the camera 120 is a still camera rather than a video camera, the electromechanical controller 122 further triggers the taking of still pictures. Optionally, the camera 120 is brought under the control of the diagnosing

radiologist at the remote location. Camera control signals from the remote location are forwarded by the address reader 96 to the electromechanical controller 122 to make the appropriate camera adjustments. The output of the camera is connected to the formatting means 46 to format the electronic optical images from the camera into messages addressed 5 to the controlling remote location.

With reference to FIGURE 4, a workflow begins 130 after the patient is injected with a contrast agent and taken into the scanning room 14. The technician starts an examination 132 by entering the patient ID and selecting a scan protocol 134. After the scans are obtained, technician views the scans 136. The technician selects a correct 10 radiologist or physician in charge 138 and sends a page 140. At the same time, the technician transmits images 142 via e-mail or the wireless communications means 44, 62 and awaits a predetermined time to receive an automatically generated acknowledgement 144.

With continuing reference to FIGURE 4, the radiologist receives the page 15 146 and executes a login 148 to access the arrived patient images. The software means 64 matches the radiologist ID code and the patient's code to ensure that the correct radiologist is reviewing the correct patient's data. If the radiologist ID code is accepted, the software authorizes the radiologist to proceed. The software means 64 generates an automatic "ok" message back to the technician. If the radiologist ID code does not match the patient's 20 code, the software declines access and generates automatic "decline" message that is sent back to the technician.

The radiologist reviews the scans 150 for correctness, completeness, proper contrast, and other relevant criteria. The radiologist may approve a release of the patient 152, request additional scans, request repetition of selected scans, or request more 25 information such as patient's files or an exterior image of the patient, which is particularly advantageous in the trauma cases. The exterior image of the patient can be taken with a hand-held digital camera or with a real-time video camera in the exam room 14 or on the scanning apparatus 16. The radiologist can control the live video from the tablet computer or the like to control zoom, field of view, and other.

30 The technician checks for the radiologist response 154. After technician receives radiologist's response, he sends an acknowledgement that it is received 156.

Accordingly, technician closes the study and releases the patient, repeats all or part of the study, or sends more data 158 to the radiologist.

As a further enhancement, two or more radiologists or physicians can view the images and communicate with one another. For example, a first radiologist can send 5 images to a second radiologist for consultation that can be carried on verbally or by typing text directly between two radiologists.

The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon a reading and understanding of the preceding detailed description. It is intended that the invention be 10 constructed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.